microATX Chassis Design Suggestions

Version 1.0

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Contents

Figures

Tables

1. Overview

microATX is a new motherboard form factor designed to meet new market trends and PC technologies. Lower system cost is the main driving force for the new form factor. The size of the form factor allows for smaller chassis, motherboard, and power supply, thus reducing the cost of entire system. The microATX form factor is also backward-compatible with the ATX form factor with some modifications.

This *Design Suggestions* document is intended to provide chassis design suggestions as a reference for OEMs to help them realize the benefits of the microATX form factor. The document does not provide design details.

microATX compliance requires that a microATX chassis design can accommodate any microATX-compliant motherboard. As used here, the phrase "microATX chassis" means a chassis that supports a motherboard that complies with the *microATX Motherboard Interface Specification*. Most of the information here relates to the mechanical design of the motherboard and other system components that interface to it, such as the motherboard mounting, back chassis I/O shield, and related mechanical elements.

This document provides the following information:

- Section 1 gives chassis-relevant information about the dimensions and mechanical features of microATX motherboards. (Motherboard designers should consult the *microATX Motherboard Interface Specification.*)
- Section 2 addresses integration of the motherboard into the chassis. This section describes the recommended mounting and back panel I/O shield.
- Section 3 discusses power supply mounting.
- Section 4 discusses thermal design suggestions.
- Section 5 shows a reference system layout.

1.1 Related Documents

- *PC 98 System Design Guide* from Intel Corporation and Microsoft Corporation
- *microATX Motherboard Interface Specification* (see Web site *http://www.teleport.com/~microatx*)
- *microATX EMC Design Suggestions*
- *microATX System Design Suggestions*
- *microATX Electrical Design Suggestions*
- *SFX Power Supply Design Guide* (small form factor power supply)
- *PCI Local Bus Specification,* Revision 2.1
- *PCI Bus Power Management Interconnect (PCI-PM) Specification,* Revision 1.0
- *Audio Codec '97 Component Specification,* Revision 1.03
- *Design Guide for Intel ATX Motherboard I/O Implementations*, V.1.0

1.2 microATX Form-factor Overview

Figure 1 shows an example layout of a microATX motherboard.

- Tall components such as the processor and memory are typically located on the opposite side from the I/O slots.
- The back I/O connectors are stacked single- and double-high to support more connectors.

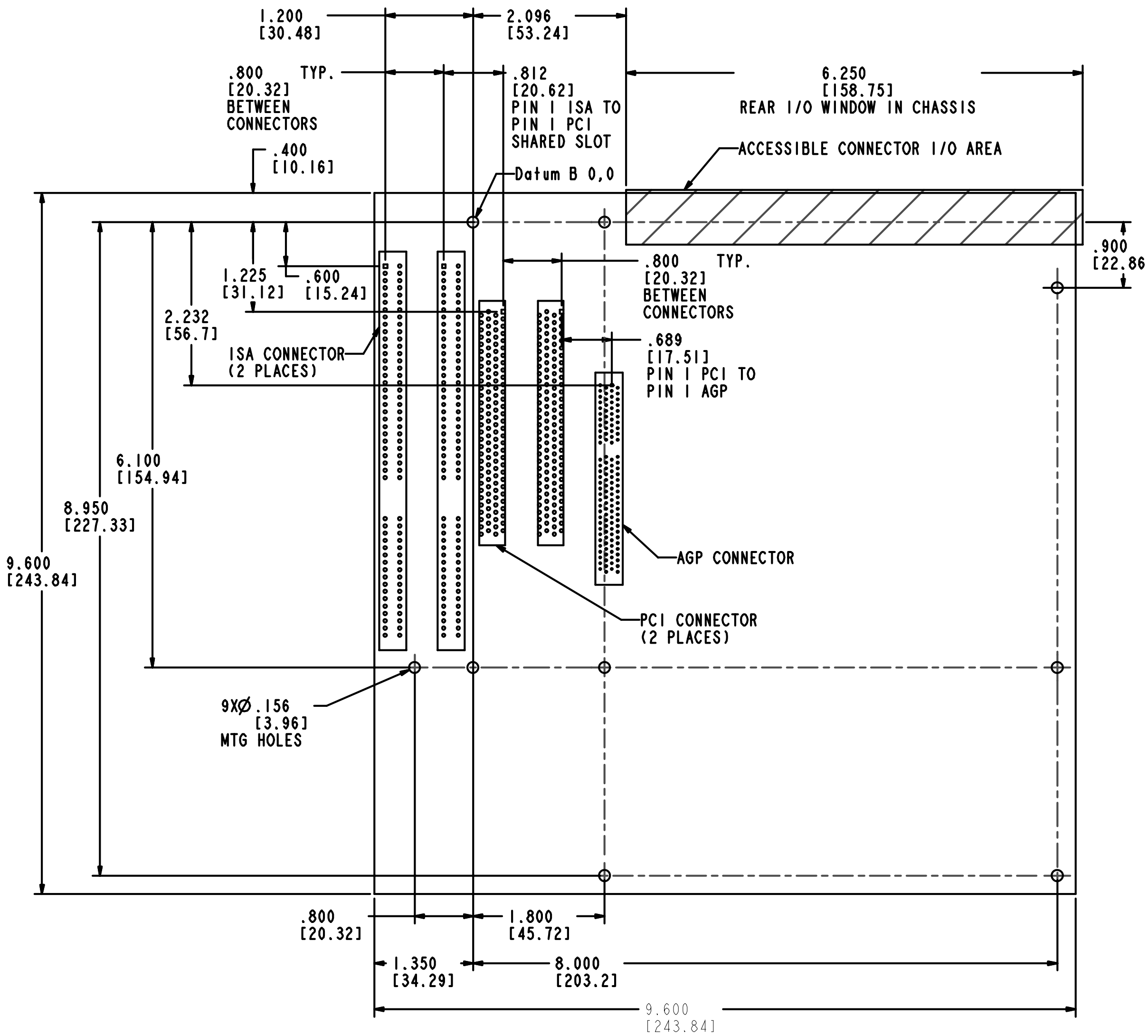


Figure 1: Example microATX Layout Diagram

Note: Datum B 0,0 = mounting location hole B.

In this figure, the board is shown oriented with the rear of the board toward the top.

The specified dimension of .800" between pins 1 on the ISA connectors indicates that the design supports only one shared ISA/PCI slot.

Where possible, the microATX mounting holes line up with mounting holes used for ATX boards. Two new holes (R and S in Figure 2) have been defined and added to provide mechanical support toward the front edge of the microATX board.

- Figure 1, the sample layout diagram, shows the exact location (dimensions) of the mounting holes for microATX boards.
- Figure 2 shows the relative outlines of the microATX and ATX boards. The letter callouts in the figure show the general location of the mounting holes for both form factors. The table in the figure indicates which holes are required for each form factor.

Chassis: To achieve full microATX compliance for chassis assemblies and to provide proper support for the board in these areas, all nine microATX board mounting locations shown in Figure 2 should be implemented in the chassis.

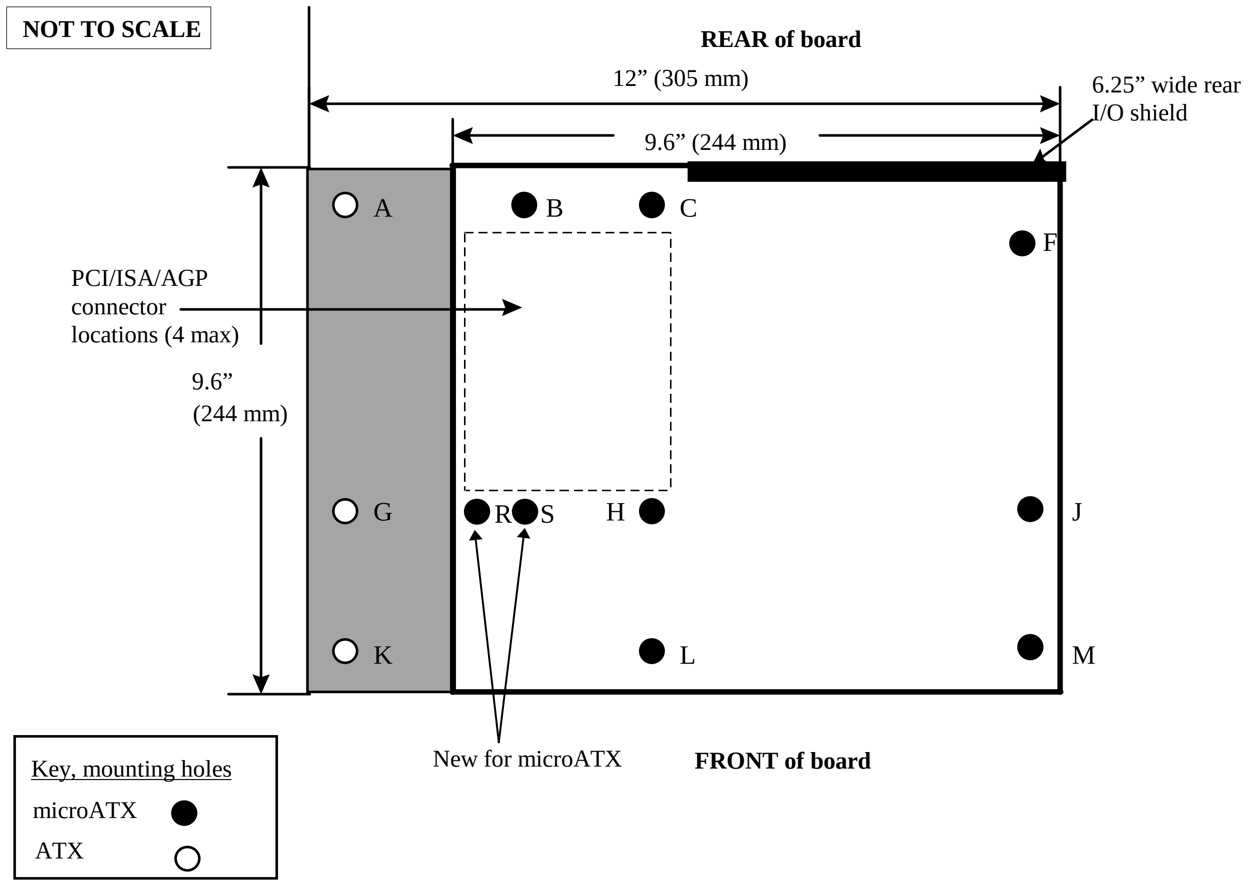
Motherboard: The board design can incorporate any combination of the microATX mounting holes shown in Figure 2 if a given board design is smaller than the 9.6 x 9.6-inch maximum size. For a full-width microATX board, hole R is required and hole S is optional. For a board that is narrower than 9.6 inches, of the two new holes, R and S, only hole S is required.

To avoid damage to traces on microATX and ATX motherboards, chassis standoffs in any locations not specified for microATX and ATX should be removable or not be implemented at all.

Table 1 specifies the status (required) of mounting holes for full ATX compliance.

Table 1: Motherboard Mounting Hole Locations

Feature	Status	Comment
Motherboard mounting hole locations	Required	See Figure 1 for exact locations and Figure 2 for an overview. For full microATX compliance, all nine microATX board mounting locations shown should be implemented in the chassis. For a microATX chassis, hole S must be implemented as a removable type standoff. For an ATX chassis, holes R and S must be implemented as removable type standoffs.



Form factor	Mounting hole locations	Notes
microATX	B, C, F, H, J, L, M, R, S	Holes R and S are added for microATX form factor. Hole B was defined in Full AT format.
ATX	A, C, F, G, H, J, K, L, M	Hole F must be implemented in all ATX 2.01-compliant chassis assemblies. It was optional in the ATX 1.1 specification.

Figure 2: microATX and ATX Form-factor Mounting Holes

Notes:

This figure is reproduced from the *microATX Motherboard Interface Specification.*

The board is shown oriented with the rear of the board toward the top.

The shaded portion to the left above indicates the greater width of the ATX form factor.

For details about mounting holes and board sizes, see the mechanical drawing in this specification.

Depending on the size of the motherboard, either one or both of holes R and S are optional for the motherboard manufacturer, but both are REQUIRED for the chassis manufacturer.

1.3 Motherboard Component Height Limits and Chassis Design

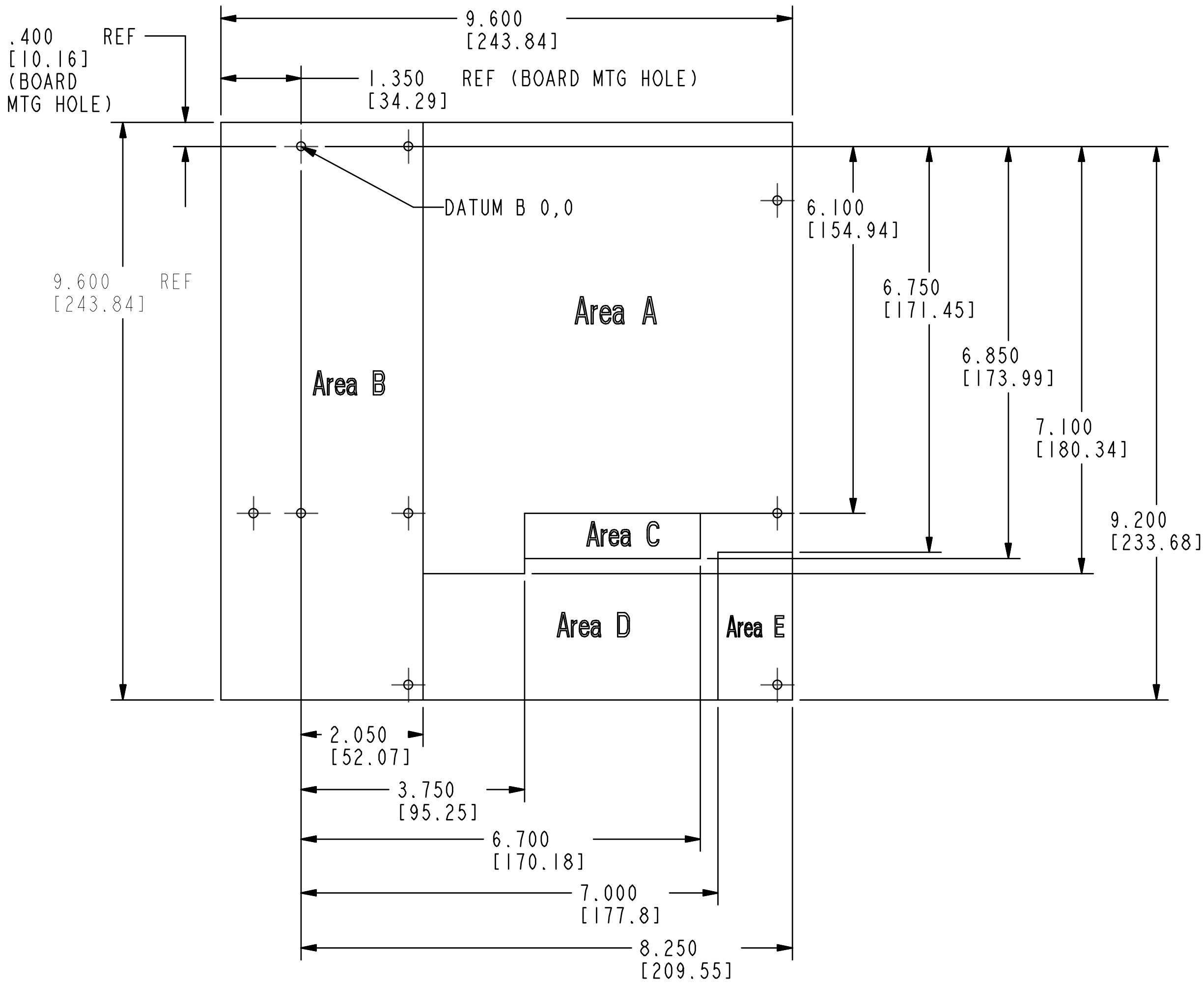
One of the major advantages of the microATX form factor is its backward-compatibility with the ATX specification. The microATX motherboard can be installed in any ATX chassis with the addition of motherboard mounts.

Table 2 lists the status of height constraints for specific areas. Figure 3 shows the required **maximum component height constraints** for the components on the PC board. For full compliance with microATX and to prevent interference with the chassis structure, power supply, or peripherals, the motherboard components should not exceed the height limit in each zone defined. Similarly, microATX-compliant power supplies, peripherals, and chassis features should not extend into the motherboard component area.

Table 2: Height Constraints

Feature	Status	Comment
microATX motherboard maximum component heights	Required	See Figure 3.
microATX chassis keepout in Area A	Required	3.0 inches (76.20mm) is required; 3.5 inches (88.90mm) is preferred.

The **required** chassis keepout for Area A is 3.0 inches (76.20mm) to facilitate dynamic considerations of components in this area on the motherboard. The **preferred (recommended)** clearance is 3.5 (88.90mm) inches to facilitate cooling solutions that require ducting. The bottom right corner of the board (as oriented in Figure 3) is the most constrained because of the presence of 5.25-inch and 3.5-inch peripherals in some chassis configurations. To maintain strict compliance to the microATX specification, careful placement of peripherals, power supply, and chassis features is required.



Area	Maximum component height (in inches)
A	Motherboard component height, 2.80 inches [71.12mm] maximum Chassis clearance over motherboard, 3.0 inches [76.20mm] required Chassis clearance over motherboard, 3.5 inches [88.90mm] recommended
B	0.60 inches [15.24mm] (expansion slot area)
C	1.50 inches [38.10mm] (see Notes)
D	1.20 inches [30.48mm] (see Notes)
E	0.35 inches [8.89mm] (see Notes)

Figure 3: microATX Motherboard Maximum Component Height Restrictions

Notes: Datum B 0,0 = mounting location hole B.

The component height requirement assumes a motherboard thickness of 0.062" (1.57 mm). The maximum heights specified for Areas C, D, and E are intended to avoid interference between motherboard components and the chassis structure and to provide backward-compatibility with ATX 2.01 or higher.

2. Motherboard Integration

2.1 Back Panel I/O Shield

A microATX chassis must provide the specified I/O shield opening to ensure that any microATX board will fit into any microATX chassis. For backward-compatibility with the ATX specification, the microATX back panel I/O shield opening is defined the same as the ATX back panel I/O shield opening. The I/O shield opening is fully defined so that all microATX and ATX I/O shields fit into the standard ATX shield opening. The shield location relative to the motherboard is fully defined to ensure compatibility between board and chassis. The I/O shield must contact clean, paint-free surfaces on the I/O shield opening in the chassis.

It is the responsibility of the system or board designer to provide mechanical support for the motherboard with the I/O shield. The I/O shield must be placed so that the motherboard card edge aligns with the riser card edge connector.

2.1.1 I/O Shield Window Dimensions

With the PC platform evolving so fast, we want to retain the greatest level of flexibility possible for future external I/O. Multimedia growth has demonstrated how user needs for enhanced I/O can change quickly. Toward the back of the chassis, the microATX and ATX Specifications define a stacked I/O area that is 6.25 inches (158.75mm) wide by 1.75 inches (44.45mm) tall. This area allows the use of stacked connectors on the motherboard to maximize the amount of I/O space available.

Figure 4 shows that the bottom of the back panel opening is 0.150 inches (3.81mm) below the top of a typical 0.062 inch (1.57 mm) thick motherboard. A **required** keepout zone of 0.1 inch (2.54 mm) is defined around the perimeter of the cutout area, on both the inside and outside surfaces of the chassis back panel. This keepout zone provides a reserved space that can be used to clip a chassis-independent I/O shield to the chassis back panel. Do not place slots, tabs, notches, or other topographical features within the keepout zone. If a feature violates the keepout zone, the chassis loses the opportunity to support an I/O shield that can be designed to fit all ATX chassis that meet the specifications in this document and that are detailed in Figure 4 and Figure 5.

For best EMI attenuation performance, do not apply paint within the keepout area, because paint can prevent proper grounding of the I/O shield. Also, motherboard connector placement must be limited as shown in Figure 5 to allow enough clearance between the connectors and chassis opening for the I/O shield structure.

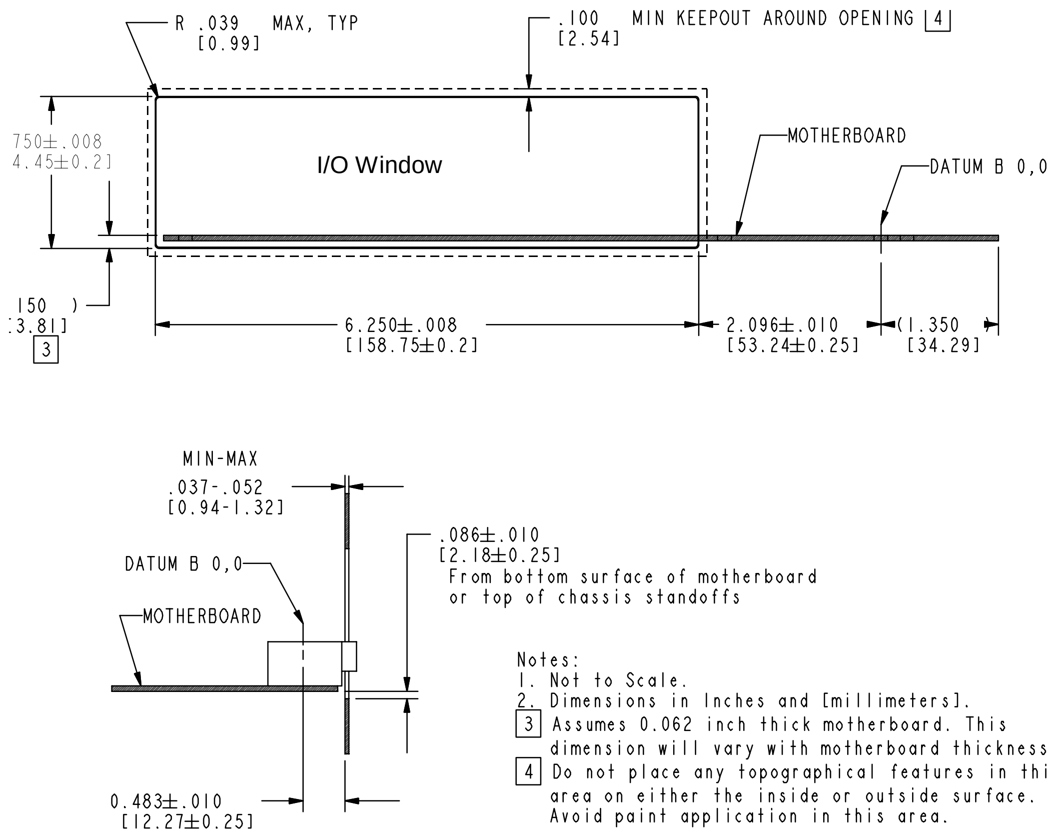


Figure 4: Chassis I/O Window Requirements

Notes:

Datum B 0,0 = mounting location hole B.

Nominal cutout size = 6.25 inches (158.75mm) by 1.75 inches (44.45mm).

Distance from top of a typical 0.062 inches (1.57 mm) motherboard to bottom of I/O cutout hole = 0.150 inches (3.81mm).

Allowable thickness of a chassis back panel that the I/O shield can clip into is in the range 0.037 inches (0.94mm) to 0.052 inches (1.32mm).

The corners of the I/O window can be rounded to a maximum radius of .039 inches (0.99mm). This allowable rounding of the corners helps case manufacturers extend the life of their hard tooling while still complying with the specification.

The 0.1 inches (2.54mm) keepout zone around the I/O window area is required in an ATX 2.01-compliant chassis. This allows microATX- and ATX 2.01-compliant I/O shields to fit into ATX 1.1- or 2.01-compliant chassis. The keepout area is needed for the shield attachment points. Avoid paint application in this area.

Figure 5 specifies the I/O connector zone. Compliance with this recommendation is necessary to ensure enough clearance between the chassis I/O window and the motherboard connectors for the I/O shield structure. If the shield provided with the motherboard requires less than the recommended clearance, then the dimensions of the I/O connector area can be waived (hatched area in Figure 5: 8.216 inches [208.69mm] by 2.226 inches [56.54mm]). To retain maximum flexibility, the exact positioning of connectors within the I/O connector zone is left to the discretion of the motherboard designer.

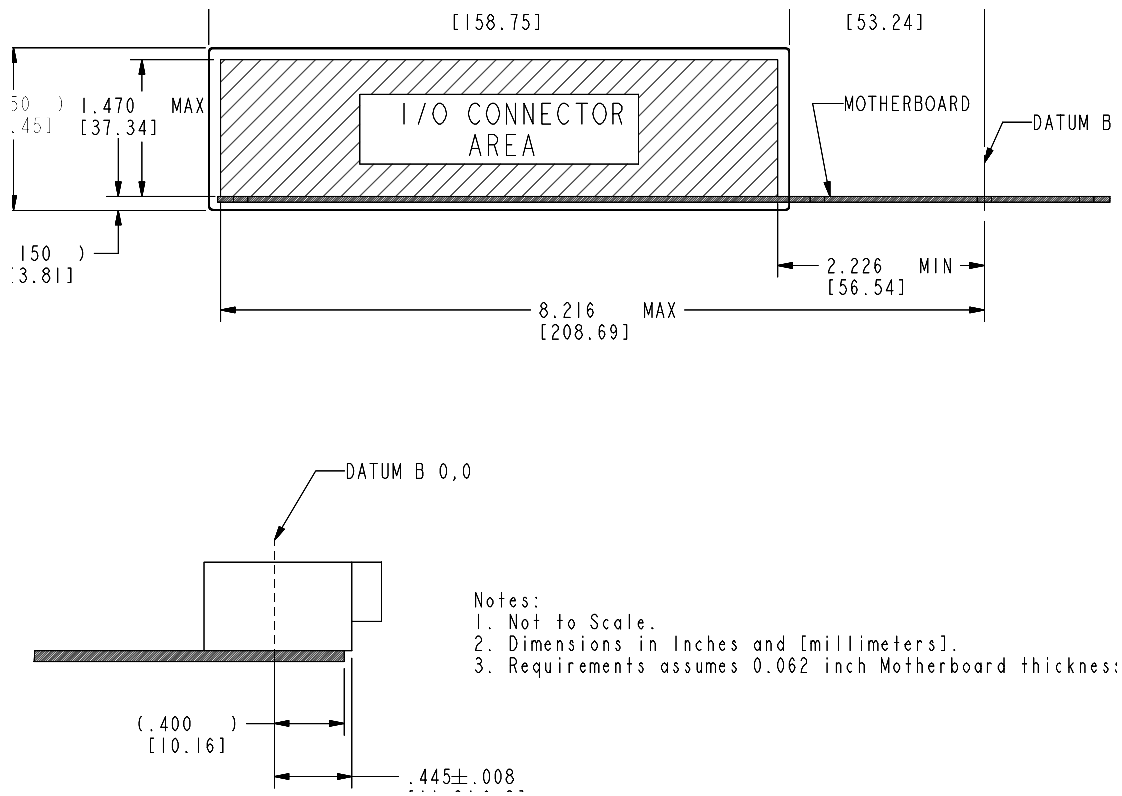


Figure 5: Motherboard I/O Connector Location Recommendations

Notes:

Datum B 0,0 = mounting location hole B.

The face of all I/O connectors should be placed 0.445 inches (11.30mm) from the reference datum and remain within the zone defined in Figure 5.

The I/O window should be a simple cutout of the chassis back panel. Recessing the I/O window will prevent the case from accepting microATX- and ATX 2.01-compliant I/O shields.

Figure 6 shows an example of back panel I/O connector layout, featuring stacked keyboard and mouse, stacked USB ports, stacked serial ports and parallel port, and stacked audio jacks and midi port. LAN, modem, or ISDN connectors could be added if the manufacturer desired. This layout is only an example; the microATX form factor allows complete flexibility in the layout of back panel I/O.

For more I/O panel examples, see the *microATX System Design Suggestions* and the *Design Guide for Intel ATX Motherboard I/O Implementations*.

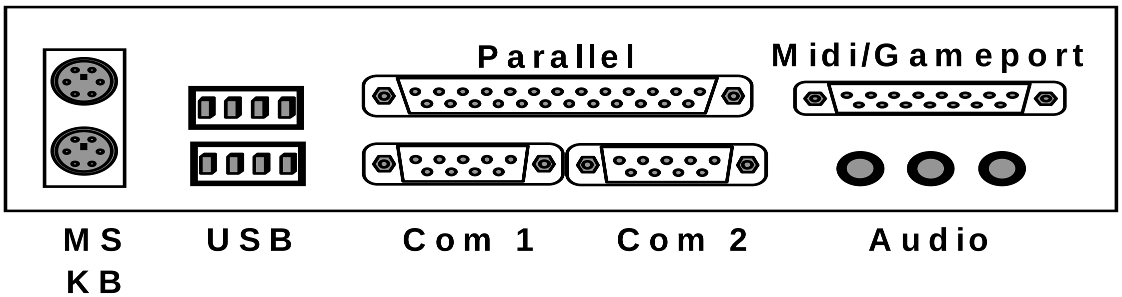


Figure 6: Back Panel I/O Connector Layout, Example

3. Power Supply Mounting

A microATX power supply can have the same form factor as an ATX or SFX power supply. The fan exhausts air from the back of the chassis in most cases. The chassis must have a cut-out for the fan air exhaust and AC plug. The chassis must also have mounting holes for the power supply. Figure 7 shows the PS/2 power supply cut-out and mounting holes. For the SFX mechanical outline, refer to the *SFX Power Supply Design Guide*.

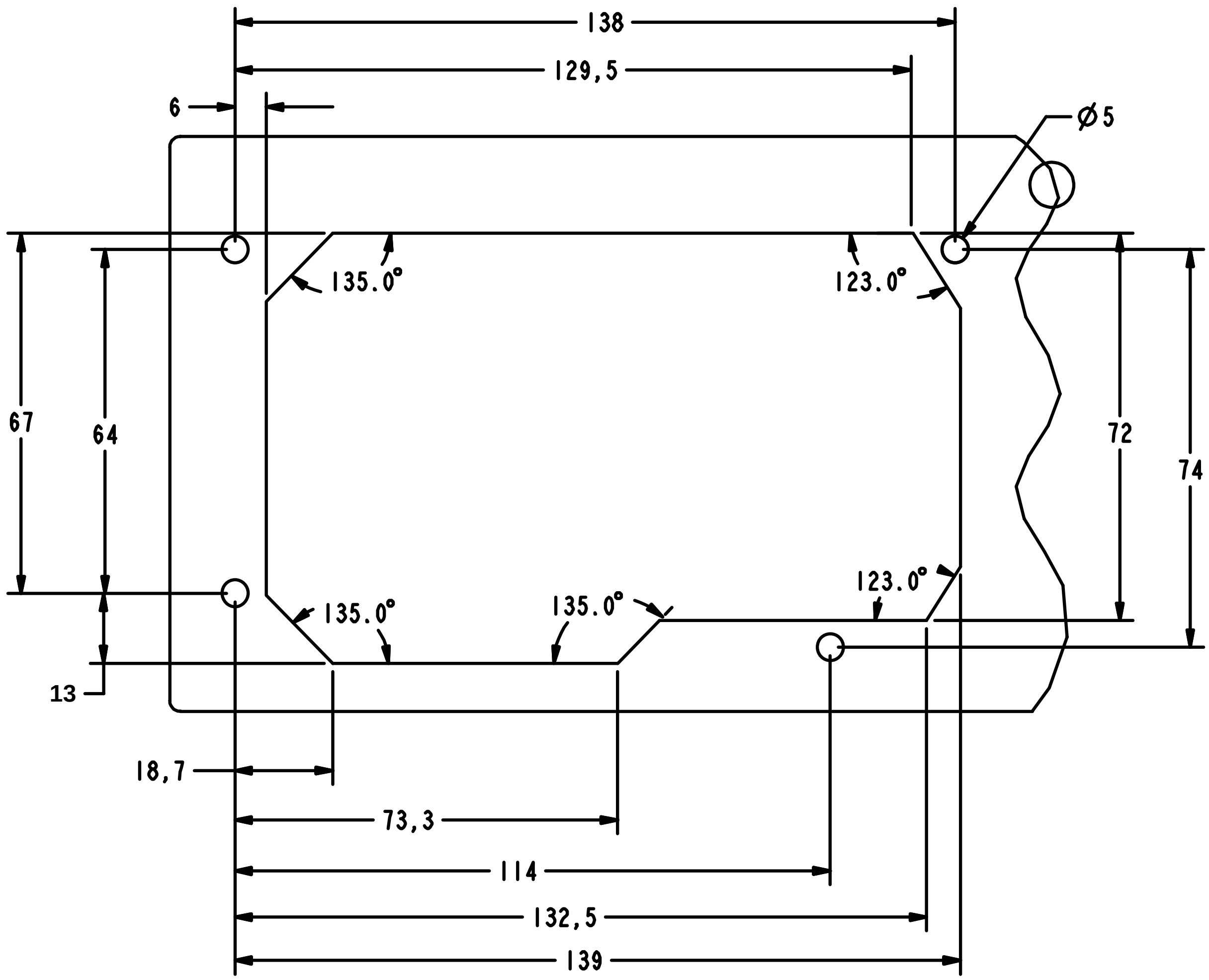


Figure 7: Power Supply Cut-out and Mounting Holes

4. Thermal Design Suggestions

This section offers thermal design suggestions for microATX form factor systems. Because of the complexity of varying chassis designs, it might be necessary to modify some of the suggestions given here to achieve an effective cooling scheme. The system's cooling scheme must ensure that all components and peripherals remain within their specified operating temperature ranges. Without sufficient air flow, performance within the system could be adversely affected.

Because system fans are in many cases speed-controlled, a good thermal design should account for various load/temperature configurations ("four-corners" as defined below). Acoustics are also an important consideration, because a cool-running system may not always operate quietly. Thermal and acoustic testing are necessary to demonstrate design performance.

The designer should be aware of system-level requirements described in the *PC 98 System Design Guide*. The minimal fan control design should allow the system to turn the fan on or off depending on operating state. Variable speed fan control can also be used; the exact speed of the fans will depend on the implementation. Because of this dependency on the specific implementation, the designer should ensure that all system acoustics and cooling requirements are met when the variable speed fan control is set for maximum fan speeds. For more detail, refer to the *PC 98 System Design Guide.*

4.1 Definitions

Light load/Heavy load—Power supply output. The light load and heavy load configurations differ in that the light load does not include add-in cards or secondary hard drives.

Four corner test—Testing with the following system configurations, where low temp and high temp refer to 22°C (room ambient) and 35°C, respectively:

1. low temp/light load
2. low temp/heavy load
3. high temp/light load
4. high temp/heavy load

Single chamber—The internal chassis space is considered a single compartment with respect to airflow. This is in contrast to a dual chamber where no significant airflow exchange occurs between the motherboard side and the power supply side of the chassis. Thus, in the dual-chambered system, cooling in either side of the chassis can be treated separately.

Active heat sink—Fan and heat sink integrated as a single unit and used to cool the processor.

4.2 Design Suggestions

The design suggestions described below were derived through testing microATX chassis assemblies that incorporate a one-fan single-chamber approach with processor heat-sink solution.

4.2.1 Fans

Fans implement the forced convection approach to cooling. Stated simply, the greater the air velocity over the surface of a component, the greater the heat transfer from that component. Airflow is drawn into the chassis by action of the power supply fan. The power supply fan induces a negative pressure (relative to room ambient) inside the chassis, which draws air in through the vents. This inflow of air from the vents is pulled through the chassis and exhausted out the power supply. The advantage of using a fan to depressurize the chassis is that cool room ambient air can be delivered (via vents) to any location where it is needed to enhance heat transfer. It has been demonstrated that, with proper implementation, using a fan to depressurize the chassis produces significantly greater cooling than does using the same fan (or two fans in series) to pressurize the chassis. Fans may differ in their characteristics, and therefore a prudent choice of fans can optimize both airflow and acoustics.

Key considerations:

- Fan size—One 80mm, 30CFM, .14amp, fan should be adequate. For lower acoustic levels, try a fan with a lower current/speed rating. For greater thermal margin try a fan with a greater cfm/speed rating.
- Fan type—Tube Axial. Airflow and acoustic characteristics of some equivalent-sized fans may differ significantly between manufacturers.
- Fan location—Using an adequate fan to exhaust air out the power supply, along with proper venting, should yield sufficient cooling throughout the chassis. The specifics of fan mounting and features of components near the fan can have a significant impact on sound generation.

4.2.2 Fan Speed Control

Fan speed control allows a system to vary its airflow as changes in load and/or temperature occur. Fan noise increases with fan speed and is a major contributor to total system noise. For systems that incorporate fan speed control, proper speed regulation is important because it is desirable to achieve low acoustic levels without overheating components. The fan speed control circuit should be designed so that it monitors temperature at a component (or several components) and adjusts fan speed as necessary to maintain the required thermal margin.

For fans used in most systems, speed control can usually be accomplished by varying the voltage level at the fan's power terminals (many power supplies/fans are equipped with this feature). An operating voltage range example for an 80mm, 30CFM, .14amp fan might be 8V to 12V DC, corresponding to 1650rpm and 2500rpm, respectively. Note that some fans need a minimum starting voltage (see the specification for your fan).

Key considerations:

- Is fan speed controlled? If so, how? Locations where temperature is monitored are important. Sensing critical component case temperatures is recommended. It is suggested that the designer try an 8V to 12V DC operating voltage range (1650rpm to 2500rpm operating speed range). Fan noise increases with fan operating voltage/speed. Minimum fan noise occurs at maximum fan power efficiency (see the specification for your fan).
- If the fan is not speed-controlled, at what voltage/speed level is it operating? Because it is not possible to vary fan speed, choose the lowest rated fan speed that will cool the system under worst-case loading/temperature conditions.

4.2.3 Venting

Proper venting is a key element in any good thermal design. As described earlier, the chassis can be depressurized by fan action, which permits an inflow of cooler air through the vents. This air can be made to flow in where needed to cool certain critical locations (ducting may be helpful here). The front vent locations are positioned in the lower half of the chassis. Back venting is an option only if a secondary system fan will be used to exhaust the chassis. Because of the compact nature of microATX chassis, air recirculation is an issue. Therefore, open venting in the back of the chassis is not recommended.

It must be emphasized that a balanced vent configuration is a critical factor; therefore, implementing too little or too much venting could produce adverse cooling effects. To increase airflow through the system, all components should present the lowest possible air impedance. Thus, generous venting into the power supply is a necessity because practically all air that enters the system must exit via the power supply. Venting at the fan exhaust should also be as liberal as possible. Power supply cables and drive signal cables should be kept short and properly folded. Components within the power supply can be made low profile and streamlined.

To eliminate possible electromagnetic compliance issues at chassis vents, neither the maximum vertical nor maximum horizontal vent dimension should exceed 1.27cm (1/2-inch).

Key considerations:

- Front bezel venting—Affects cooling of motherboard side and helps deliver airflow to processor. The bezel vent area should be as large as possible. Tests show a high degree of cooling for an area of $23.0cm^2$.
- Rear chassis venting— Can be used in conjunction with a secondary system fan.
- Chassis venting peripheral bay—Cools peripherals. Minimal venting here ($<5cm^2$) should produce adequate results. In fact, implementing too much venting here may cause lower airflow in other areas of the chassis.
- Power supply— Full venting across the front of the power supply. Tests show a high degree of cooling for an area of $48.4cm^2$ at the front. Low profile and streamlined components in the power supply offer decreased airflow impedance. Keep cables short and folded appropriately.

5. Other Design Considerations

Figure 8 shows a reference system layout.

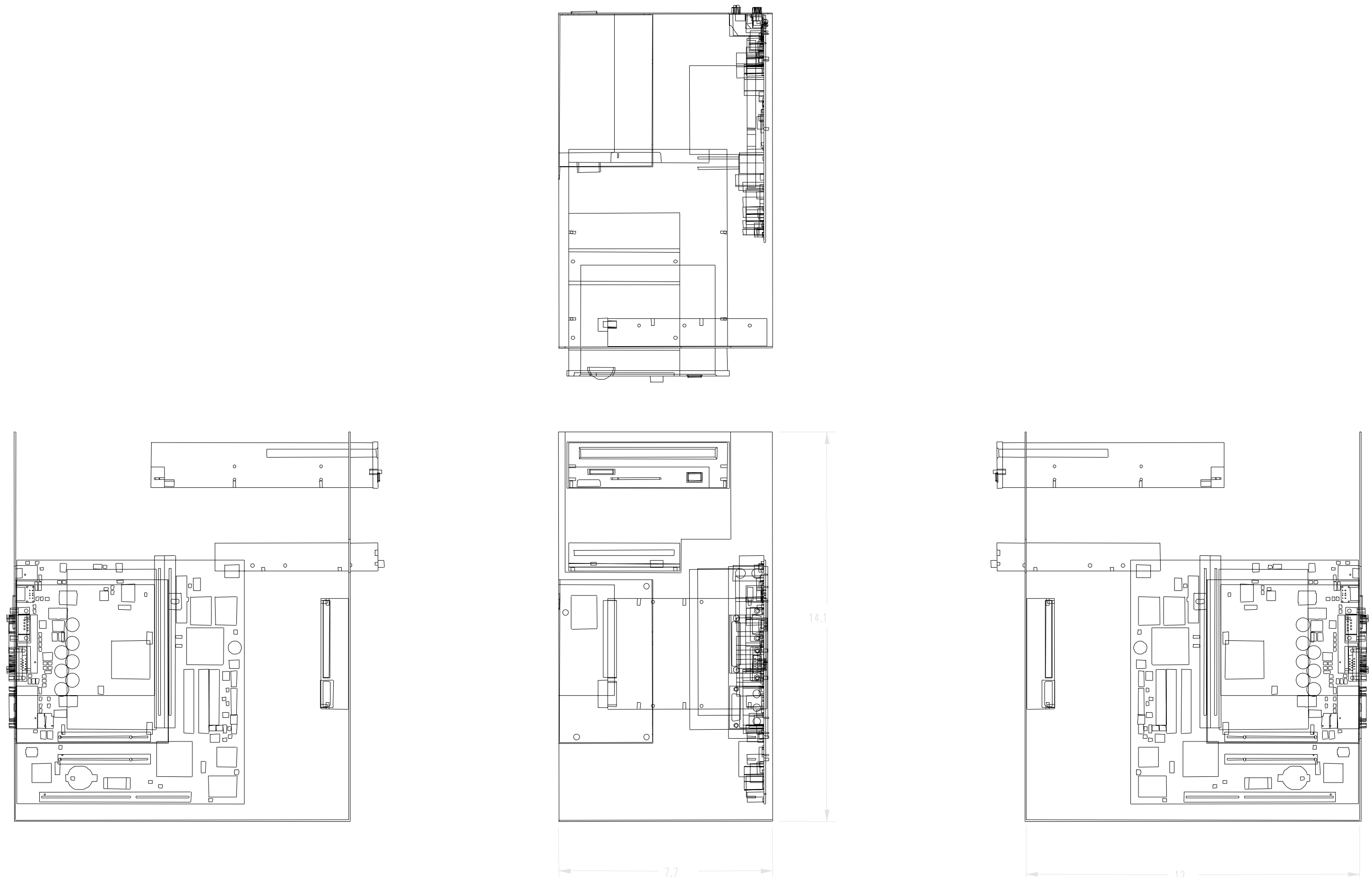


Figure 8: microATX System Reference Layout